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(57) Abstract

A method for the human-assisted generation and application of pseudo-random keys for the purpose of encoding and decoding digital watermarks to and from a digitized data stream. A pseudo-random key and key application "envelope" are generated and stored using guideline parameters input by a human engineer interacting with a graphical representation of the digitized data stream. Key "envelope" information is permanently associated with the pseudo-random binary string comprising the key. Key and "envelope" information are then applied in a digital watermark system to the encoding and decoding of digital watermarks.

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METHOD FOR AN ENCRYPTED DIGITAL WATERMARK

FIELD OF INVENTION

With the advent of computer networks and digital multimedia, protection of intellectual property has become a prime concern for creators and publishers of digitized copies of copyrightable works, such as musical recordings, movies, and video games. One method of protecting copyrights in the digital domain is to use "digital watermarks". Digital watermarks can be used to mark each individual copy of a digitized work with information identifying the title, copyright holder, and even the licensed owner of a particular copy. The watermarks can also serve to allow for secured metering and support of other distribution systems of given media content and relevant information associated with them, including addresses, protocols, billing, pricing or distribution path parameters, among the many things that could constitute a "watermark." For further discussion of systems that are oriented around content-based addresses and directories, see U.S. Patent No. 5,428,606 Moskowitz. When marked with licensing and ownership information, responsibility is created for individual copies where before there was none. More information on digital watermarks is set forth in "Steganographic Method and Device" - The DICE Company, U.S. application Serial No. 08/489,172, the disclosure of which is hereby incorporated by reference. Also, "Technology: Digital

Commerce", Denise Caruso, New York Times, August 7, 1995 "Copyrighting in the Information Age", Harley Ungar, ONLINE MARKETPLACE, September 1995, Jupiter Communications further describe digital watermarks.

Additional information on other methods for hiding information signals in content signals, is disclosed in U.S. Patent No. 5,319,735 - Preuss et al. and U.S. Patent No. 5,379,345 - Greenberg.

Digital watermarks can be encoded with random or pseudo random keys, which act as secret maps for locating the watermarks. These keys make it impossible for a party without the key to find the watermark - in addition, the encoding method can be enhanced to force a party to cause damage to a watermarked data stream when trying to erase a random-key watermark.

It is desirable to be able to specify limitations on the application of such random or pseudo random keys in encoding a watermark to minimize artifacts in the content signal while maximizing encoding level. This preserves the quality of the content, while maximizing the security of the watermark. Security is maximized because erasing a watermark without a key results in the greatest amount of perceptible artifacts in the digital content. It is also desirable to separate the functionality of the decoder side of the process to provide fuller recognition and substantiation of the protection of goods that are essentially digitized bits, while ensuring the security of the encoder and the encoded content. It is also desirable that the separate decoder be incorporated into an agent, virus, search engine, or other autonomously operating or search function software. This would make it possible for parties possessing a decoder to verify the presence of valid watermarks in a data stream, without accessing the contents of the watermark. It would also be possible to scan or search archives for files containing watermarked

content, and to verify the validity of the presence of such files in an archive, by means of the information contained in the watermarks. This scenario has particular application in screening large archives of files kept by on-line services and internet archives. It is further a goal of such processes to bring as much control of copyrights and content, including its pricing, billing, and distribution, to the parties that are responsible for creating and administering that content. It is another goal of the invention to provide a method for encoding multiple watermarks into a digital work, where each watermark can be accessed by use of a separate key. This ability can be used to provide access to watermark information to various parties with different levels of access. It is another goal of the invention to provide a mechanism which allows for accommodation of alternative methods encoding and decoding watermarks from within the same software or hardware infrastructure. This ability can be used to provide upgrades to the watermark system, without breaking support for decoding watermarks created by previous versions of the system. It is another goal of the invention to provide a mechanism for the certification and authentication, via a trusted third party, and public forums, of the information placed in a digital watermark. This provides additional corroboration of the information contained in a decoded digital watermark for the purpose of its use in prosecution of copyright infringement cases. It also has use in any situation in which a trusted third party verification is useful. It is another goal of this invention to provide an additional method for the synchronization of watermark decoding software to an embedded watermark signal that is more robust than previously disclosed methods.

SUMMARY OF THE INVENTION

The invention described herein is a human-assisted random key generation and application system for use in a digital watermark system. The invention allows an engineer or other individual, with specialized knowledge regarding processing and perception of a particular content type, such as digital audio or video, to observe a graphical representation of a subject digital recording or data stream, in conjunction with its presentation (listening or viewing) and to provide input to the key generation system that establishes a key generation "envelope", which determines how the key is used to apply a digital watermark to the digital data stream. The envelope limits the parameters of either or both the key generation system and the watermark application system, providing a rough guide within which a random or pseudo random key may be automatically generated and applied. This can provide a good fit to the content, such that the key may be used to encode a digital watermark into the content in such a manner as to minimize or limit the perceptible artifacts produced in the watermarked copy, while maximizing the signal encoding level. The invention further provides for variations in creating, retrieving, monitoring and manipulating watermarks to create better and more flexible approaches to working with copyrights in the digital domain.

Such a system is described herein and provides the user with a graphical representation of the content signal over time. In addition, it provides a way for the user to input constraints on the application of the digital watermark key, and provides a way to store this information with a random or pseudo random key sequence which is also generated to apply to a content signal. Such a system would also be more readily adaptable by current techniques to master content with personal

computers and authoring/editing software. It would also enable individuals to monitor their copyrights with decoders to authenticate individual purchases, filter possible problematic and unpaid copyrightable materials in archives, and provide for a more generally distributed approach to the monitoring and protection of copyrights in the digital domain.

DETAILED DESCRIPTION

Digital watermarks are created by encoding an information signal into a larger content signal. The information stream is integral with the content stream, creating a composite stream. The effectiveness and value of such watermarks are highest when the informational signal is difficult to remove, in the absence of the key, without causing perceptible artifacts in the content signal. The watermarked content signal itself should contain minimal or no perceptible artifacts of the information signal. To make a watermark virtually impossible to find without permissive use of the key, its encoding is dependent upon a randomly generated sequence of binary 1s and 0s, which act as the authorization key. Whoever possesses this key can access the watermark. In effect, the key is a map describing where in the content signal the information signal is hidden. This represents an improvement over existing efforts to protect copyrightable material through hardware-based solutions always existing outside the actual content. "Antipiracy" devices are used in present applications like VCRs, cable television boxes, and digital audio tape (DAT) recorders, but are quite often disabled by those who have some knowledge of the location of the device or choose not to purchase hardware with these "additional security features." With digital watermarks, the "protection," or more accurately, the

deterrent, is hidden entirely in the signal, rather than a particular chip in the hardware.

Given a completely random key, which is uniformly applied over a content signal, resulting artifacts in the watermarked content signal are unpredictable, and depend on the interaction of the key and the content signal itself. One way to ensure minimization of artifacts is to use a low information signal level. However, this makes the watermark easier to erase, without causing audible artifacts in the content signal. This is a weakness. If the information signal level is boosted, there is the risk of generating audible artifacts.

The nature of the content signal generally varies significantly over time. During some segments, the signal may lend itself to masking artifacts that would otherwise be caused by high level encoding. At other times, any encoding is likely to cause artifacts. In addition, it might be worthwhile to encode low signal level information in a particular frequency range which corresponds to important frequency components of the content signal in a given segment of the content signal. This would make it difficult to perform bandpass filtering on the content signal to remove watermarks.

Given the benefits of such modifications to the application of the random key sequence in encoding a digital watermark, what is needed is a system which allows human-assisted key generation and application for digital watermarks. The term "human-assisted key generation" is used because in practice, the information describing how the random or pseudo random sequence key is to be applied must be stored with the key sequence. It is, in essence, part of the key itself, since the random or pseudo random sequence alone is not enough to encode, or possibly decode the watermark.

Encoding of digital watermarks into a content signal can be done in the time domain, by modifying content samples on a sample by sample basis, or in the frequency domain, by first performing a mathematical transform on a series of content samples in order to convert them into frequency domain information, subsequently modifying the frequency domain information with the watermark, and reverse transforming it back into time-based samples. The conversion between time and frequency domains can be accomplished by means of any of a class of mathematical transforms, known in general as "Fourier Transforms." There are various algorithmic implementations and optimizations in computer source code to enable computers to perform such transform calculations. The frequency domain method can be used to perform "spread spectrum" encoding implementations. Spread spectrum techniques are described in the prior art patents disclosed. Some of the shortcomings evident in these techniques relate to the fixed parameters for signal insertion in a sub audible level of the frequency-based domain, e.g., U.S. Patent No. 5,319,735 Preuss et al. A straightforward randomization attack may be engaged to remove the signal by simply over-encoding random information continuously in all sub-bands of the spread spectrum signal band, which is fixed and well defined. Since the Preuss patent relies on masking effects to render the watermark signal, which is encoded at -15 dB relative to the carrier signal, inaudible, such a randomization attack will not result in audible artifacts in the carrier signal, or degradation of the content. More worrisome, the signal is not the original but a composite of an actual frequency in a known domain combined with another signal to create a "facsimile" or approximation, said to be imperceptible to a human observer, of the original copy. What results is the forced maintenance of one

original to compare against subsequent "suspect" copies for examination. Human-assisted watermarking would provide an improvement over the art by providing flexibility as to where information signals would be inserted into content while giving the content creator the ability to check all subsequent copies without the requirement of a single original or master copy for comparison. Thus the present invention provides for a system where all necessary information is contained within the watermark itself.

Among other improvements over the art, generation of keys and encoding with human assistance would allow for a better match of a given informational signal (be it an ISRC code, an audio or voice file, serial number, or other "file" format) to the underlying content given differences in the make-up of the multitudes of forms of content (classical music, CD-ROM versions of the popular game DOOM, personal HTML Web pages, virtual reality simulations, etc.) and the ultimate wishes of the content creator or his agents. This translates into a better ability to maximize the watermark signal level, so as to force maximal damage to the content signal when there is an attempt to erase a watermark without the key. For instance, an engineer could select only the sections of a digital audio recording where there were high levels of distortion present in the original recording, while omitting those sections with relatively "pure" components from the watermark process. This then allows the engineer to encode the watermark at a relatively higher signal level in the selected sections without causing audible artifacts in the signal, since the changes to the signal caused by the watermark encoding will be masked by the distortion. A party wanting to erase the watermark has no idea, however, where or at what level a watermark is encoded, and so must choose to "erase" at the maximum level across the

entire data stream, to be sure they have obliterated every instance of a watermark.

In the present invention, the input provided by the engineer is directly and immediately reflected in a graphical representation of content of that input, in a manner such that it is overlaid on a representation of the recorded signal. The key generation "envelope" described by the engineer can be dictated to vary dynamically over time, as the engineer chooses. The graphical representation of the content is typically rendered on a two dimensional computer screen, with a segment of the signal over time proceeding horizontally across the screen. The vertical axis is used to distinguish various frequency bands in the signal, while the cells described by the intersection of vertical and horizontal unit lines can signify relative amplitude values by either a brightness or a color value on the display.

Another possible configuration and operation of the system would use a display mapping time on the horizontal axis versus signal amplitude on the vertical axis. This is particularly useful for digital audio signals. In this case, an engineer could indicate certain time segments, perhaps those containing a highly distorted signal, to be used for watermark encoding, while other segments, which contain relatively pure signals, concentrated in a few bandwidths, may be exempt from watermarking. The engineer using a time vs. amplitude assisted key generation configuration would generally not input frequency limiting information.

In practice, the system might be used by an engineer or other user as follows:

The engineer loads a file containing the digitized content stream to be watermarked onto a computer. The engineer runs the key generation application and opens the file to be watermarked. The application opens a

window which contains a graphical representation of the digitized samples. Typically, for digital audio, the engineer would see a rectangular area with time on the horizontal axis, frequency bands on the vertical axis, and varying color or brightness signifying signal power at a particular time and frequency band. Each vertical slice of the rectangle represents the frequency components, and their respective amplitude, at a particular instant ("small increment") of time. Typically, the display also provides means for scrolling from one end of the stream to the other if it is too long to fit on the screen, and for zooming in or out magnification in time or frequency. For the engineer, this rectangular area acts as a canvas. Using a mouse and/or keyboard, the engineer can scroll through the signal slowly marking out time segments or frequency band minima and maxima which dictate where, at what frequencies, and at what encoding signal level a watermark signal is to be encoded into the content, given a random or pseudo random key sequence. The engineer may limit these marks to all, none or any of the types of information discussed above. When the engineer is finished annotating the content signal, he or she selects a key generation function. At this point, all the annotated information is saved in a record and a random or pseudo random key sequence is generated associated with other information. At some later point, this combined key record can be used to encode and/or decode a watermark into this signal, or additional instances of it.

A suitable pseudo-random binary sequence for use as a key may be generated by: collecting some random timing information based on user keystrokes input to a keyboard device attached to the computer, performing a secure one way hash operation on this random timing data, using the results of the hash to seed a block cipher algorithm

loop, and then cycling the block cipher and collecting a sequence of 1s and 0s from the cipher's output, until a pseudo-random sequence of 1s and 0s of desired length is obtained.

The key and its application information can then be saved together in a single database record within a database established for the purpose of archiving such information, and sorting and accessing it by particular criteria. This database should be encrypted with a passphrase to prevent the theft of its contents from the storage medium.

Another improvement in the invention is support for alternate encoding algorithm support. This can be accomplished for any function which relates to the encoding of the digital watermark by associating with the pseudo-random string of 1s and 0s comprising the pseudo-random key, a list of references to the appropriate functions for accomplishing the encoding. For a given function, these references can indicate a particular version of the function to use, or an entirely new one. The references can take the form of integer indexes which reference chunks of computer code, of alphanumeric strings which name such "code resources," or the memory address of the entry point of a piece of code already resident in computer memory. Such references are not, however, limited to the above examples. In the implementation of software, based on this and previous filings, each key contains associated references to functions identified as CODEC - basic encode/decode algorithm which encodes and decodes bits of information directly to and from the content signal, MAP - a function which relates the bits of the key to the content stream, FILTER - a function which describes how to pre-filter the content signal, prior to encoding or decoding, CIPHER - a function which provides encryption and decryption services for information

contained in the watermark, and ERRCODE - a function which further encodes/decodes watermark information so that errors introduced into a watermark may be corrected after extraction from the content signal.

Additionally, a new method of synchronizing decoder software to an embedded watermark is described. In a previous disclosure, a method whereby a marker sequence of N random bits was generated, and used to signal the start of an encoded watermark was described. When the decoder recognizes the N bit sequence, it knows it is synchronized. In that system the chance of a false positive synchronization was estimated at 1/(N^2) ("one over (N to the power of 2)"). While that method is fairly reliable, it depends on the marker being encoded as part of the steganographic process, into the content stream. While errors in the encoded bits may be partially offset by error coding techniques, error coding the marker will require more computation and complexity in the system. It also does not completely eliminate the possibility that a randomization attack can succeed in destroying the marker. A new method is implemented in which the encoder pre-processes the digital sample stream, calculating where watermark information will be encoded. As it is doing this, it notes the starting position of each complete watermark, and records to a file, a sequence of N-bits representing sample information corresponding to the start of the watermark, for instance, the 3rd most significant bit of the 256 samples immediately preceding the start of a watermark. This would be a 256 bit marker. The order in which these markers are encountered is preserved, as it is important. The decoder then searches for matches to these markers. It processes the markers from first to last, discarding each as it is found, or possibly not found within a certain scanning distance, and proceeding with the remaining markers. This method does not modify

the original signal with marker information and has the added benefit that high-significance sequences can be used, requiring that an attack based on randomizing markers do very obvious damage to the content stream.

With multichannel encoding, both private and public keys, similar in use to those from public-key cryptosystems, could be provided for authentication by concerned third party vendors and consumers, as well as contribute to better management and protection of copyrights for the digital world that already exist in the physical world. For more information on public-key cryptosystems see US Pat No 4,200,770 Diffie-Hellman, 4,218,582 Hellman, 4,405,829 RSA, 4,424,414 Hellman Pohlig. In addition, any number of key "designations" between "public" and "private" could be established, to provide various access privileges to different groups. Multi-channel watermarks are effected by encoding separate watermark certificates with separate keys by either interleaving windows in the time domain or by using separate frequency bands in the frequency domain. For instance, 3 separate watermarks could be encoded by using every third sample window processed to encode a corresponding certificate. Alternatively, complete watermarks could be interleaved. Similarly, the frequency range of an audio recording might be partitioned into 3 sub-ranges for such a purpose. Use of multi-channel watermarks would allow groups with varying access privileges to access watermark information in a given content signal. The methods of multichannel encoding would further provide for more holographic and inexpensive maintenance of copyrights by parties that have differing levels of access priority as decided by the ultimate owner or publisher of the underlying content. Some watermarks could even play significant roles in adhering to given filtering (for example, content that is not intended for all

observers), distribution, and even pricing schemes for given pieces of content. Further, on-the-fly watermarking could enhance identification of pieces of content that are traded between a number of parties or in a number of levels of distribution. Previously discussed patents by Preuss et al. and Greenberg and other similar systems lack this feature.

Further improvements over the prior art include the general capacity and robustness of the given piece of information that can be inserted into media content with digital watermarks, described in **Steganographic Method and Device** and further modified here, versus "spread spectrum-only" methods. First, the spread spectrum technique described in US. Patent No. 5,319,735 Preuss et al. is limited to an encoding rate of 4.3 8-bit symbols per second within a digital audio signal. This is because of the nature of reliability requirements for spread spectrum systems. The methods described in this invention and those of the previous application, "Steganographic Method and Device," do not particularly adhere to the use of such spread spectrum techniques, thus removing such limitation. In the steganographic derived implementation the inventors have developed based on these filings, watermarks of approximately 1,000 bytes (or 1000x 8 bits) were encoded at a rate of more than 2 complete watermarks per second into the carrier signal. The carrier signal was a two channel (stereo) 16-bit, 44.1 Khz recording. The cited encoding rate is per channel. This has been successfully tested in a number of audio signals. While this capacity is likely to decrease by 50% or more as a result of future improvements to the security of the system, it should still far exceed the 4.3 symbols per second envisioned by Preuss et al. Second, the ability exists to recover the watermarked information with a sample of the overall piece of digitized content (that is, for instance, being

able to recover a watermark from just 10 seconds of a 3 minute song, depending on the robustness or size of the data in a given watermark) instead of a full original. Third, the encoding process described in **Steganographic Method and Device** and further modified in this invention explicitly seeks to encode the information signal in such a way with the underlying content signal as to make destruction of the watermark cause destruction of the underlying signal. The prior art describes methods that confuse the outright destruction of the underlying content with "the level of difficulty" of removing or altering information signals that *may* destroy underlying content. This invention anticipates efforts that can be undertaken with software, such as Digidesign's Sound Designer II or Passport Design's Alchemy, which gives audio engineers (similar authoring software for video also exists, for instance, that sold by Avid Technology, and others as well as the large library of picture authoring tools) very precise control of digital signals, "embedded" or otherwise, that can be purely manipulated in the frequency domain. Such software provides for bandpass filtering and noise elimination options that may be directed at specific ranges of the frequency domain, a ripe method for attack in order to hamper recovery of watermark information encoded in specific frequency ranges.

Separating the decoder from the encoder can limit the ability to reverse the encoding process while providing a reliable method for third parties to be able to make attempts to screen their archives for watermarked content without being able to tamper with all of the actual watermarks. This can be further facilitated by placing separate signals in the content using the encoder, which signal the presence of a valid watermark, e.g. by providing a "public key accessible" watermark channel which contains information comprised

of a digitally signed digital notary registration of the watermark in the private channel, along with a checksum verifying the content stream. The checksum reflects the unique nature of the actual samples which contain the watermark in question, and therefore would provide a means to detect an attempt to graft a watermark lifted from one recording and placed into another recording in an attempt to deceive decoding software of the nature of the recording in question. During encoding, the encoder can leave room within the watermark for the checksum, and analyze the portion of the content stream which will contain the watermark in order to generate the checksum before the watermark is encoded. Once the checksum is computed, the complete watermark certificate, which now contains the checksum, is signed and/or encrypted, which prevents modification of any portion of the certificate, including the checksum, and finally encoded into the stream. Thus, if it is somehow moved at a later time, that fact can be detected by decoders. Once the decoder functions are separate from the encoder, watermark decoding functionality could be embedded in several types of software including search agents, viruses, and automated archive scanners. Such software could then be used to screen files or search out files from archive which contain specific watermark information, types of watermarks, or lack watermarks. For instance, an online service could, as policy, refuse to archive any digital audio file which does not contain a valid watermark notarized by a trusted digital notary. It could then run automated software to continuously scan its archive for digital audio files which lack such watermarks, and erase them.

Watermarks can be generated to contain information to be used in effecting software or content metering services. In order to accomplish this, the watermark

would include various fields selected from the following information:

title identification;

unit measure;

unit price;

percentage transfer threshold at which liability is incurred to purchaser;

percent of content transferred;

authorized purchaser identification;

seller account identification;

payment means identification;

digitally signed information from sender indicating percent of content transferred; and

digitally signed information from receiver indicating percent of content received.

These "metering" watermarks could be dependent on a near continuous exchange of information between the transmitter and receiver of the metered information in question. The idea is that both sides must agree to what the watermark says, by digitally signing it. The sender agrees they have sent a certain amount of a certain title, for instance, and the receiver agrees they have received it, possibly incurring a liability to pay for the information once a certain threshold is passed. If the parties disagree, the transaction can be discontinued before such time. In addition, metering watermarks could contain account information or other payment information which would facilitate the transaction.

Watermarks can also be made to contain information pertaining to geographical or electronic distribution restrictions, or which contain information on where to locate other copies of this content, or similar content. For instance, a watermark might stipulate that a recording is for sale only in the United States, or that it is to be sold only to persons connecting to an online

distribution site from a certain set of internet domain names, like ".us" for United States, or ".ny" for New York. Further a watermark might contain one or more URLs describing online sites where similar content that the buyer of a piece of content might be interested in can be found.

A digital notary could also be used in a more general way to register, time stamp and authenticate the information inside a watermark, which is referred to as the certificate. A digital notary processes a document which contains information and assigns to it a unique identification number which is a mathematical function of the contents of the document. The notary also generally includes a time stamp in the document along with the notary's own digital signature to verify the date and time it received and "notarized" the document. After being so notarized, the document cannot be altered in any way without voiding its mathematically computed signature. To further enhance trust in such a system, the notary may publish in a public forum, such as a newspaper, which bears a verifiable date, the notarization signatures of all documents notarized on a given date. This process would significantly enhance the trust placed in a digital watermark extracted for the purpose of use in settling legal disputes over copyright ownership and infringement.

Other "spread spectrum" techniques described in the art have predefined time stamps to serve the purpose of verifying the actual time a particular piece of content is being played by a broadcaster, e.g., U.S. Patent No. 5,379,345 Greenberg, not the insertion and control of a copyright or similar information (such as distribution path, billing, metering) by the owner or publisher of the content. The Greenberg patent focuses almost exclusively on concerns of broadcasters, not content creators who deal with digitized media content when

distributing their copyrightable materials to unknown parties. The methods described are specific to spread spectrum insertion of signals as "segment timing marks" to make comparisons against a specific master of the underlying broadcast material-- again with the intention of specifying if the broadcast was made according to agreed terms with the advertisers. No provisions are made for stamping given audio signals or other digital signals with "purchaser" or publisher information to stamp the individual piece of content in a manner similar to the sales of physical media products (CDs, CD-ROMs, etc.) or other products in general (pizza delivery, direct mail purchases, etc.). In other words, "interval-defining signals," as described in the Greenberg patent, are important for verification of broadcasts of a time-based commodity like time and date-specific, reserved broadcast time, but have little use for individuals trying to specify distribution paths, pricing, or protect copyrights relating to given content which may be used repeatedly by consumers for many years. It would also lack any provisions for the "serialization" and identification of individual copies of media content as it can be distributed or exchanged on the Internet or in other on-line systems (via telephones, cables, or any other electronic transmission media). Finally, the Greenberg patent ties itself specifically to broadcast infrastructure, with the described encoding occurring just before transmission of the content signal via analog or digital broadcast, and decoding occurring upon reception.

While the discussion above has described the invention and its use within specific embodiments, it should be clear to those skilled in the art that numerous modifications may be made to the above without departing from the spirit of the invention, and that the

scope of the above invention is to be limited only by the claims appended hereto.

What is Claimed:

1. A method for using a computer to generate a random or pseudo random key for a digital watermark system wherein said random key includes:

a random or pseudo random sequence of binary 1s and 0s

information describing the application of the random sequence to a stream of digitized samples wherein said information includes:

at least one list of time delimiters describing segments of the stream;

at least one list of frequency delimiters describing frequency bands to be included in watermark computations; and

a signal encoding level;

wherein the method comprises the step of receiving human interactive input information used to describe limits on where, at what level, and at what frequencies the random binary information of the random key is to be applied to the stream of digitized samples in encoding the digital watermark;

wherein said human interactive input information comprises at least one of the following datum:

a list of time delimiters;

a list of frequency delimiters; and

a signal encoding level.

2. The method of claim 1 further comprising the step of selecting said stream of digitized samples from a list provided by a computer system.

3. The method of claim 2 further comprising the step of creating and displaying a graphical representation on the display device of the computer

system, wherein said graphical representation includes a time axis and a signal frequency axis.

4. The method of claim 2 further comprising the step of creating and displaying a graphical representation on the display device of the computer system, wherein said graphical representation includes a time axis and a signal amplitude axis.

5. The method of claim 3 or 4, further comprising the step of updating the graphical display to reflect receipt of new human interactive input information.

6. The method of claim 5 further comprising the step of generating a random or pseudo random sequence of 1s and 0s.

7. The method of claim 6 further comprising the step of storing input information in association with the random sequence of 1s and 0s as a single record in a database of such records.

8. The method of claim 7 wherein the record is encrypted using a pass phrase.

9. The method of claim 1 where the stream of digitized samples contains a digital audio recording.

10. The method of claim 1 where the stream of digitized samples to be watermarked contains a digital video recording.

11. The method of claim 6 wherein the process of generating the random sequence comprises the steps of:

(a) collecting a series of random bits derived from keyboard latency intervals in random typing;

(b) processing the initial series of random bits through a secure one-way hash function;

(c) using the results of one-way hash function to seed a block encryption cipher loop;

(d) cycling through the block encryption loop, and extracting the least significant bit of each result after cycle; and

(e) concatenating the block encryption output bits into the random key sequence

12. A method of encoding and decoding a digital watermark where the encoder and decoder are separate software applications or hardware devices.

13. The method of claim 12 wherein the decoder functionality is embedded in a software search engine, word-wide web-crawler file scanning engine, intelligent agent, or a virus.

14. The method of claim 12 wherein the decoder can access only a limited number of watermark channels, corresponding to public watermark keys, or any keys otherwise made available to said decoder.

15. The method of claim 12 wherein the decoder is capable of detecting the presence of a valid watermark but not of accessing the information in the watermark.

16. The method of claim 12 wherein the encoder places a separate signal, which does not interfere with the watermark, into a content stream, where said separate signal can indicate

watermark synchronization information, which helps locate watermarks in the content; and

the presence of a valid watermark in the content.

17. A method of using digital watermarks to convey information which is to be used for a content metering service, wherein said watermarks contain at least one of the following pieces of information:

title identification;

unit measure;

unit price;

percentage transfer threshold at which liability is incurred to purchaser;

percent of content transferred;

authorized purchaser identification;

seller account identification;

payment means identification;

digitally signed information from sender indicating percent of content transferred; and

digitally signed information from receiver indicating percent of content received.

18. A method of encoding digital watermarks which contain information pertaining to distribution restrictions and a location of an addressable directory containing related content, where said watermarks contain at least one of the following pieces of information:

geographical constraints on distribution (state, country, etc);

logical constraints on distribution;

Universal Resource Locator (URL);

telephone number;

Internet Protocol address;

Internet domain name;

email address; and

file name.

19. A method of encoding multiple digital watermarks into a single content stream wherein each watermark is encoded with a separate key.

20. The method of claim 18 wherein watermark information from each watermark is interleaved in the time domain.

21. A method of claim 18 wherein watermark information from each watermark is placed into specific frequency bands, or interleaved in the frequency domain.

22. A method of associating with a pseudo-random key, a list of component function references, which dictate what component functions are applied to the encoding and decoding of a digital watermark using the key in question.

23. A method of providing synchronization of a decoder to watermark which consists of the following steps:

a) recording a feature of sample stream, or a marker extracted from the sample stream immediately preceding the start of an encoded watermark;

b) recording the order in which a list of markers was encountered in the sample stream;

c) storing a list of such markers and the order of their appearance in a file for use by the decoder;

d) optionally, associating the stored information of step c) with a watermark key or watermark receipt or content title;

e) in the decoder, selecting a marker from the file in step c) such that the selected marker is not previous

in order to any other marker previously selected in decoding the sample stream in question;

f) attempting to find a feature or marker in the portion of the sample stream currently under processing;

g) at such time as the currently selected marker is deemed unlikely to be found, discarding it and proceeding to step e);

h) at such time as marker is found, decoding the watermark, then proceeding to step e) unless the sample stream is exhausted.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00652

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :H04L 9/00
US CL :380/20
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 380/20, 54

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y, P	US, A, 5,530,759 (BRAUDAWAY ET AL) 25 June 1996, see Figs. 1-2.	1-11, 22

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 06 MAY 1997	Date of mailing of the international search report 09 JUN 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer SALVATORE CANGIALOSI Telephone No. (703) 305-1837

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00652

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-11 and 22

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00652

BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING
This ISA found multiple inventions as follows:

Group I, Claims 1-11, 22, drawn to an method of generating an encrypted digital watermark.

Group II, Claims 12-21 and 23 method of making and using a digital watermark.

The inventions listed as Groups I-II do not relate to a single inventive concept under PCT Rule 13.1 because under PCT Rule 13.2, they lack the same or corresponding technical features for the following Reasons: The invention of Group I lack the separate software, hardware devices or content monitoring. The invention of Group II lack the pseudo-Random key.